

# Cells to Self - Formative Evaluation

## Cheek Cell Puzzle

Joyce Ma and Rosario Sotelo

June 2019

THIS IS NOT A DEFINITIVE FINAL REPORT

FORMATIVE evaluation studies like this one often:

- **are conducted quickly**, which may mean
  - small sample sizes
  - expedited analyses
  - brief reports
  
- **look at an earlier version** of the exhibit/program, which may mean
  - a focus on problems and solutions, rather than successes
  - a change in form or title of the final exhibit/program

## Cells to Self - Formative Evaluation

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### PURPOSE

This formative evaluation was conducted for the *Cheek Cell Puzzle* prototype to address the questions:

- What are visitors doing at the exhibit?
- What do visitors find interesting about the exhibit experience?
- What is confusing or frustrating about the prototype?
- What do visitors think the exhibit was about? In particular, what do visitors think the pieces represent?
- Why do visitors leave? Specifically, do they leave before they complete the puzzle?
- Is there any additional information visitors want at the exhibit?

### METHOD

#### The Prototype

*Cheek Cell Puzzle* is a jigsaw puzzle made of 17 pieces of a 3D-printed model of a single layer of cheek cells. Visitors can place the cheek cell pieces together on a flat surface that represents another layer of cheek epithelial tissue. An outline of each puzzle piece is drawn in blue on that flat surface to help visitors position the puzzle pieces. The edges of each piece is uneven to model how the cells fit together to make tissue. See Figure 1 and Figure 2.

Figure 1. *Cheek Cell Puzzle* prototype completed (left) and with outstanding pieces (right).

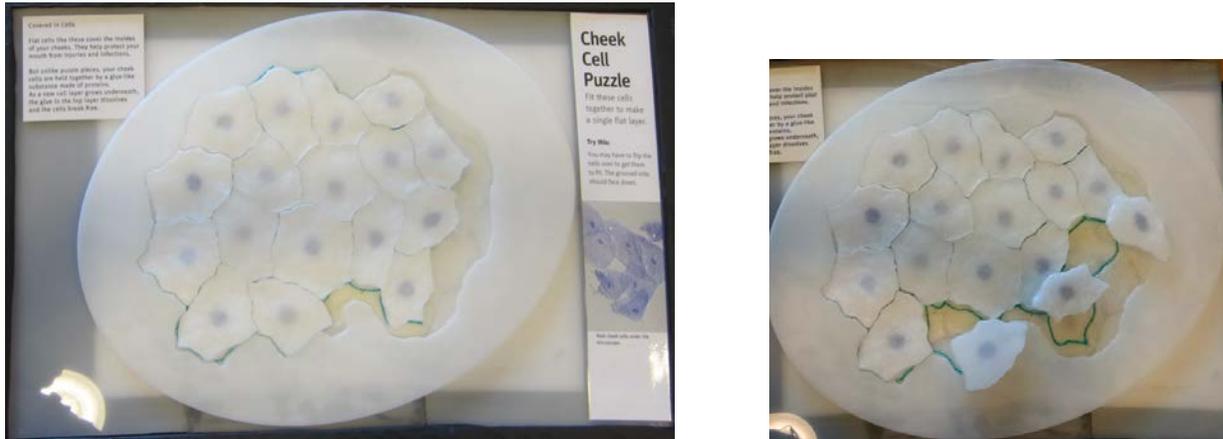
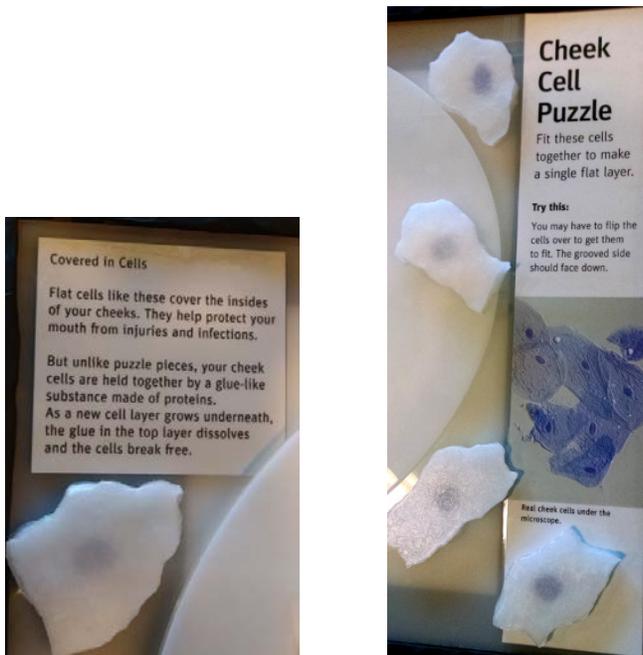


Figure 2. *Cheek Cell Puzzle* labels with puzzle pieces.



## Participants

The study collected data over 3 days, on June 12th, 13th and 16th. We observed every other visitor who (1) appeared 8 years old or older (2) and stopped at the exhibit for more than five second. When that individual left the exhibit, we approached that visitor whom we just observed for an interview. If that individual was a minor, we first talked with the accompanying adult to secure consent before asking the minor interview questions.

The demographic information of the study subjects is shown in Table 1. In total, we observed 31 visitors and their groups and talked with 22 individuals<sup>1</sup>.

**Table 1. Demographics of study subjects**

	Count Observed (percentage of 31)	Count Interviewed (percentage of 22)
<b>Age Group</b>		
Child	5 (16%)	3 (14%)
Teen	8 (26%)	7 (32%)
Adult	18 (58%)	12 (55%)
<b>Gender</b>		
Female	22 (71%)	16 (73%)
Male	9 (29%)	6 (27%)
<b>Group Type</b>		
Multigenerational	23 (74%)	17 (77%)
Minors	4 (13%)	3 (14%)
Adult Peer	3 (10%)	2 (9%)
Adult Singleton	1 (3%)	0 (0%)

## RESULTS

### What visitors did at *Cheek Cell Puzzle* (Observations)

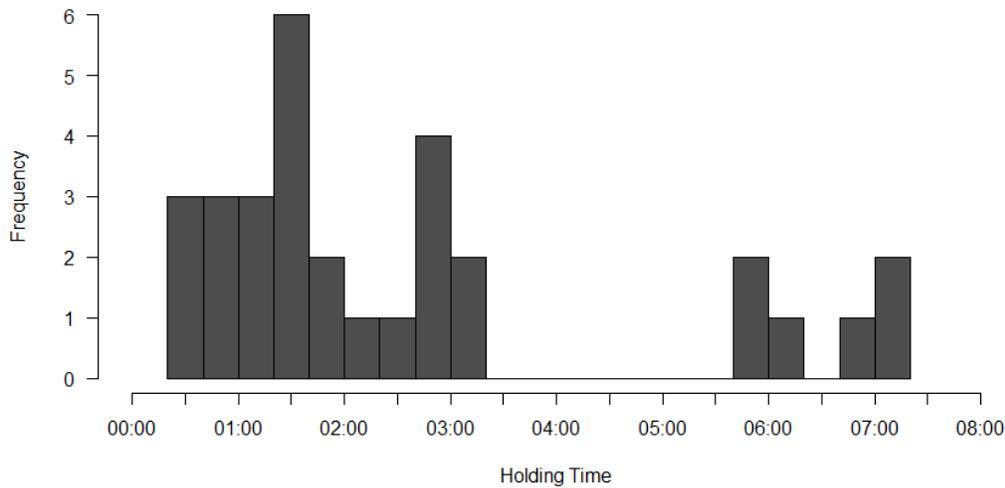
Our observations found that visitors had little trouble getting started with the puzzle. Many (22/31 or 71%) of the visitors came to the jigsaw puzzle with some of the pieces already in place. Of the eight visitors who approached the puzzle already completed, all but one immediately ‘reset’ the puzzle by removing all the pieces.

Visitors tended to spend a long time at the exhibit, with a median holding time of one minute and 15 seconds. A histogram of *Cheek Cell Puzzle*'s holding times (Figure 3) shows two groups of visitors, those that stay less than four minutes and those who stay beyond 5 minutes.<sup>2</sup>

<sup>1</sup> One visitor did not complete his/her interview.

<sup>2</sup> We were, however, unable to determine distinguishing characteristics for the two groups from the data collected.

**Figure 3. Histogram of holding times, with min = 00:26, median = 01:51, mean = 02:39, and max = 07:20.**



Furthermore, observations showed that *Cheek Cell Puzzle* is a strong multi-user exhibit. A large majority (25/31 or 81%) of the visitors worked together with members of their visiting group to solve the puzzle. More specifically, we found that visitors were engaging in social behavior such as placing pieces at the same time, handing someone else a piece to try, pointing something out to others, and taking turns placing the puzzle pieces.

#### What visitors found interesting and not interesting (Interviews)

On average, visitors found the prototype *Somewhat Interesting* (4) on a Likert scale from *Not Interesting* (1) to *Interesting* (5). Table 1 provides the tally.

**Table 2. Visitors' interest ratings in response to the question, 'How interesting did you find that exhibit?'**

Interest Rating	Count Interviewed (percentage of 22)
Interesting	6 (27%)
<b>Somewhat Interesting</b>	11 (50%)
Neutral	4 (18%)
Somewhat Not Interesting	0 (0%)
Not Interesting	1 (5%)

Visitors found the exhibit interesting for a variety of reasons including: they liked the hands-on aspect of putting it together and they liked puzzles in general. Table 3 provides the categories of responses visitors gave with example quotes. Alternatively, some visitors thought that *Cheek Cell Puzzle* was not interesting because it was not attractive or was difficult to use or understand (Table 4).

**Table 3. What visitors found interesting with examples quotes.**

Visitors liked the hands-on aspect of putting it together (8/22; 36%)
V8: Figure out pieces and how they go together.
V11: Putting it together.
V17: Hands on. [Anything else?] Being able to see how cells come together.
Visitors like puzzles in general (6/22; 27%).
V4: I like jigsaw puzzles
V18: It's a puzzle.
Visitors appreciated the texture of the puzzle pieces (3/22; 14%)
V13: How pieces are texturized surface of skin and underpart
Visitors were interested in cheek cells (2/22; 9%)
V3: Interesting it was a cheek cell.
It was fun to do with others (1/22; 5%)
V5: Fun to do with the family.

**Table 4. What visitors found *not* interesting with example quotes.**

Visitors did not find it attractive (3/22; 14%)
V7: It doesn't stand out compared to others.
It was difficult to use (3/22; 14%).
V24: Doesn't quite fit. Big gap here. [Anything else?] Pieces have slanted bits.
Visitors found it difficult to understand (2/22; 9%)
V23: Not a clear purpose; what the educational goal is.

**What visitors found confusing or frustrating (Interviews)**

In their interviews, some of the visitors reported feeling confused or frustrated by aspects of the puzzle beyond the challenges inherent in solving a jigsaw puzzle. These included confusion with which side of the pieces should be facing up, the irregular three-dimensional quality of each piece's edges, and the meaning of the blue outlines on the base surface. Table 5 provides example quotes to illustrate each of the issues visitors raised.

**Table 5. Points of confusion or frustration with example quotes.**

Visitors were confused as to which side of the puzzle pieces should be facing up (6/22; 27%)
V1: (Adult in the group) Top & bottom. We couldn't tell if it was top or bottom
V7: You can put them down either way. A sign of up & down
V18: You have to know which side is up or down.

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**The edge of the pieces made the puzzle difficult (5/22; 23%)**


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V4: I had to move 3 pieces before I could get one to fit. [Say more] Groove angle

V13: Edges uneven confusing to decide which pieces connect. Pieces do not fit correctly.

V23: The ridge not sure if they represent something.

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**Visitors were confused by the (blue) outline of the puzzle pieces (2/22; 9%)**


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V13: Not sure to match the cracks or blue line. Blue lines don't match shape.

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**Visitors' understanding of what the exhibit was about (Interview)**

A plurality (8/ 21 or 38%) of visitors thought the exhibit showed them something about how cells fit together. Other visitors were less specific and thought *Cheek Cell Puzzle* was about some other aspect of cells or cells more generally, while a few visitors never mentioned cells or simply did not know what the exhibit was trying to show. See Table 6 for examples of visitors' responses when they were asked to describe what the exhibit was about.

**Table 6. What visitors thought the exhibit was about, with example quotes.**

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**How cells fit together (8/ 21; 38%) with 2 mentioning specifically cheek cells**


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V3: Educate us in cheek cells. Puzzle helps you learn about it by putting pieces in.

V5: Resembles the way cells fit together using puzzle.

V15: Cells in a cheek swab. How they fit together.

V18: How cells are arranged

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**Something else about cells (6/21; 29%) with one visitor mentioning specifically cheek cells**


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V8: I read the cell itself made to protect itself. The tissue does have a purpose.

V24: Animal cells don't have formula. Animals' cells float around.

V28: cheek cells

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**Other with no mention of cells of any type (3/21; 14%)**


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V16: Figuring out how to put pieces together. Working as a team.

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**Not sure (3/21; 14%)**


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When we asked visitors what they thought the puzzle pieces represented, only 4/21 (19%) of the visitors interviewed specifically mentioned cheek cells, while a majority (12/21 or 57%) thought that they represented cells or parts of a cell. The remaining visitors either did not know or made no mention of cells. See Table 7. This finding coupled with the prior result indicate that visitors had a notion that Cheek Cell Puzzle showed them something about cells, but only a minority of visitors could articulate something more specific.

**Table 7. Tally of visitors who thought the puzzle pieces represented (cheek) cells.**

The puzzle pieces represented ...	Count Interviewed (percentage of 21)	Example quotes
Cells (with no mention of cheek cells)	12 (57%)	V6: Cells V9: Pieces of cell V17: Single cell V23: Assume it's a cell
Cheek Cells	4 (19%)	V15: Cells in a cheek swab. V28: cheek cells
Something else	3 (14%)	V1: Looks like ice. V8: Tissue itself, breaking apart under trauma. V20: Land
Unknown	2 (10%)	V27: I don't know. [Any guesses?] No.

### Reasons for leaving the exhibit (Interviews and Observations)

Although about one-third of visitors (11/31) were observed to have completed the puzzle, the majority (11/21 or 52%) of the visitors we interviewed felt that they finished the puzzle when we asked them why they were leaving the exhibit. Some of these groups may have simply placed the final pieces on top of the other pieces without fitting them into the same layer. Only a quarter (5/21) of the visitors reported leaving because the puzzle was too difficult to complete, while the remaining visitors left because the needs of other members in their visiting group caused them to move on. This finding suggests that few visitors left the exhibit in frustration and that the challenge level was appropriate.

### Additional information visitors wished they had (Interviews)

Most (15/21 or 71%) of the visitors interviewed reporting not wanting any information in addition to what they already found at the current prototype. A minority of visitors asked for additional images of cheek cells and clearer indications for how to position the puzzle pieces. Table 8 provides the entire list of visitors' requests to help inform the next iteration of *Cheek Cell Puzzle*.

**Table 8. What additional information visitors wanted with example quotes.**

More images of cheek cells (3/21; 14%)
V3: If they showed more images of cheek cells for more insight.
V15: More pictures of actual cheek cells. Display petri dish with swab showing real size.
V17: Target more kids. Have actual pictures so they can visually see it.

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Clearly indicate which side should face up (2/21; 10%)

V1: Purple dots. If it told you darker side is up or bottom.

V18: Maybe mark which side it should be make it easier.

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Clarify the meaning of the blue lines (1/21; 5%)

V8: The blue lines look like they were put after the fact.

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## SUMMARY AND NEXT STEPS

This formative evaluation found that the *Cheek Cell Puzzle* worked well as a multiuser exhibit with long holding times for the visitors who stopped at the prototype. Overall, visitors found the exhibit experience *Somewhat Interesting*. Visitors liked the exhibit for a variety of reasons; key among these were visitors appreciated the act of fitting together the puzzle pieces and liked jigsaws in general. About a quarter of the visitors left the exhibit because they found the puzzle too frustrating or difficult.

The connection between the puzzle and scientific content, however, was weak for many visitors, and a few visitors were confused by what *Cheek Cell Puzzle* was supposed to show them. In particular, although a majority of visitors thought the individual pieces represented cells, very few mentioned cheek cells and a few visitors' language suggest that they thought the pieces were the parts of one cell. Close to a quarter of the visitors interviewed did not mention cells at all but seemed to think of the exhibit as purely a jigsaw puzzle instead of a model of cheek cells they were assembling.

The findings points to opportunities to strengthen the connection to the scientific content and to better convey the exhibit as not just a puzzle but a model of the structure of epithelial tissue. In particular, visitors' comments suggest (1) clarifying that the uneven edges model the three-dimensional quality of cells and (2) including additional images to give multiple perspectives of cheek cells to better tie the puzzle pieces to those cells. Resolving usability issues (i.e., indicating which side faces up and the meaning of the blue lines) may further help improve visitors' *Cheek Cell Puzzle* experience.

## ACKNOWLEDGEMENTS

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**APPENDIX A: OBSERVATION NOTES AND INTERVIEW QUESTIONS****Observation Notes**

State of puzzle at start?    Some Pieces Placed      No Pieces Placed      All Pieces Placed

Dwell Time (mm:ss): \_\_\_\_\_

Placed piece?    Multiple Individuals                      One person                      Interviewed                      None

Are visitors taking turns?    Other sharing behaviors?

Reset puzzle?    Start      Middle              End      None

Complete puzzle at exit?    YES    NO

**Questions**

1. How interesting did you find that exhibit? Would you say that was ...

Not Interesting	Somewhat Not Interesting	Neutral	Somewhat Interesting	Interesting
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a. What made it \_\_\_\_\_ for you? Anything else that made it \_\_\_\_\_ for you?

2. Was there anything confusing or frustrating? [Probe one: Anything else?]

3. What do you think this exhibit is trying to show, if anything?

4. [If they did not mention cheek cells up to this point] What do you think the puzzle pieces represented?

5. Is there any additional information you wanted but didn't find at the exhibit?

6. Any reason why you decided to leave the exhibit when you did?